

Remarks

Reconsideration and reexamination of the above-identified patent application, as amended, are respectfully requested. Claims 1, 3-7, and 9-13 are pending in this application upon entry of this Amendment. In this Amendment, the Applicant has amended claims 1 and 7. No claims have been cancelled or added in this Amendment. Of the pending claims, claims 1 and 7 are independent claims.

In this Amendment, the Applicant has amended independent claims 1 and 7 to recite that “the magnesium sulfate is at least 50% by weight of the water-soluble binder and the at least one other inorganic sulfate compound is less than 50% by weight of the water-soluble binder”. The Applicant has further amended independent claim 1 to recite that “the at least one other inorganic sulfate compound forms a mixed crystal in combination with the magnesium sulfate upon the mixture being dried”. Support for these amendments is found on, for example, Tables 4-7 and the explanation thereof on page 22 of the specification and page 18, lines 6-12 of the specification.

Double Patenting

In the Office Action mailed January 10, 2006, the Examiner provisionally rejected claims 1 and 4-7 under the judicially created doctrine of obviousness-type double patenting as being unpatentable over claims 1 and 4-6 of co-pending Application No. 11/053,051. As indicated above, the Applicant has amended independent claims 1 and 7. The Applicant believes that amended independent claims 1 and 7 overcome the noted provisional rejection. Claims 4-6 depend from amended independent 1 and include the limitations therein. Accordingly, the Applicant respectfully requests reconsideration and withdrawal of the noted provisional rejection.

Claim Rejections - 35 U.S.C. § 103

The Examiner rejected independent claims 1 and 7 and dependent claims 3, 5, and 10 under 35 U.S.C. § 103(a) as being unpatentable over JP 53119724 ("JP '724") in view of JP 54151508 ("JP '508") and further in view of U.S. Patent No. 4,941,938 issued to Karlsson ("Karlsson"). The Applicant believes that the claimed invention is patentable under 35 U.S.C. § 103(a) over any combination of JP '724, JP '508, and Karlsson and has amended independent claims 1 and 7 to more clearly define the claimed invention.

The Examiner rejected dependent claims 4 and 9 under 35 U.S.C. § 103(a) as being unpatentable over JP '724 in view of JP '508 and further in view of Karlsson and U.S. Patent No. 4,423,764 issued to Seeney et al. ("Seeney"). The Examiner rejected dependent claims 6 and 11 under 35 U.S.C. § 103(a) as being unpatentable over JP '724 in view of JP '508 and further in view of Karlsson and U.S. Patent No. 4,812,278 issued to Natori ("Natori"). The Examiner rejected dependent claim 12 under 35 U.S.C. § 103(a) as being unpatentable over JP '724 in view of JP '508 and further in view of Karlsson and U.S. Patent No. 5,573,055 issued to Melling ("Melling"). The Examiner rejected dependent claim 13 under 35 U.S.C. § 103(a) as being unpatentable over JP '724 in view of JP '508 and further in view of Karlsson and U.S. Patent No. 4,761,264 issued to Nishio ("Nishio").

1. The Claimed Invention

The claimed invention is generally directed to a water-soluble casting mold and its manufacture. Amended independent claim 1 recites a water-soluble casting mold. The mold includes a mixture having a refractory granular material for casting sand and a water-soluble binder containing an inorganic sulfate compound comprising magnesium sulfate and at least one other inorganic sulfate compound selected from aluminum sulfate, sodium sulfate, nickel sulfate, and manganese sulfate. The magnesium sulfate is at least 50% by weight of the water-soluble binder and the at least one other inorganic sulfate compound is less than 50% by weight of the water-soluble binder. The at least one other inorganic sulfate

compound forms a mixed crystal in combination with the magnesium sulfate upon the mixture being dried. The inorganic sulfate compound exists in a state of hydrate containing crystal water after the mixture is dried.

Amended independent claim 7 recites a method for manufacturing a water-soluble casting mold. The method includes a first step of obtaining casting sand by mixing a refractory granular material for casting sand with a water-soluble binder containing an inorganic sulfate compound comprising magnesium sulfate and at least one other inorganic sulfate compound selected from aluminum sulfate, sodium sulfate, nickel sulfate, and manganese sulfate and water in which the magnesium sulfate is at least 50% by weight of the binder and the at least one other inorganic sulfate compound is less than 50% by weight of the binder. The method includes a second step of forming the resulting casting sand. The method includes a third step of obtaining a mold by drying the casting sand in such a manner that the inorganic sulfate compound in the casting sand is kept retaining at least a portion of the crystal water.

Features of the claimed invention include employing magnesium sulfate (containing crystal water) as a base material of a binder capable of maintaining the strength of a water-soluble casting mold, and improving the collapsing property by water of the casting mold thereby facilitating recovery of the binder. Further, another feature of the claimed invention is to use the magnesium sulfate in combination with another inorganic sulfate compound containing crystal water (i. e., at least one other inorganic sulfate compound selected from aluminum sulfate, sodium sulfate, nickel sulfate, manganese sulfate) which easily forms a mixed crystal with the magnesium sulfate at the time of drying, thereby increasing the strength of a water-soluble casting mold at the time of drying, and also restraining the decrease in the strength of the water-soluble casting mold at the time of moisture absorption. The claimed limitations of the magnesium sulfate being at least 50% by weight of the water-soluble binder and the at least one other inorganic sulfate compound being less than 50% by weight of the water-soluble binder are to achieve the above-mentioned effects of the claimed invention.

2. The Claimed Invention Compared to the Cited Art

A1. JP 53-119724 (JP '724)

Page 2, lines 13-19 and page 3, lines 5-16 of the Applicant's specification describe the pertinence of JP '724. As is explained, JP '724 discloses, for example, a technique of using magnesium sulfate as a binder for a refractory granular material for casting sand and mixing the refractory granular material with magnesium sulfate and water, thereafter forcibly drying the obtained mixture at a temperature of 200°C to 300°C, thereby obtaining a mold (see page 2, lines 13-19 of the Applicant's specification). However, with respect to the mold disclosed in JP '724, because magnesium sulfate hydrate is dehydrated at a temperature of 200°C or higher, the magnesium sulfate in the obtained mold is supposed to be an anhydride. Magnesium sulfate in the anhydride state has a rather decreased strength as compared with that in a hydrate state containing crystal water. Therefore, in order to retain a sufficient strength of the mold, the additional amount of magnesium sulfate has to be increased and that is significantly disadvantageous in terms of moldability of the mold, easiness of drying, and recovery of the binder and thereby results in decrease of working efficiency (see page 3, lines 5-16 in the Applicant's specification).

JP '724 does not teach or suggest the technical idea of increasing the strength of a water-soluble casting mold by adjusting an inorganic sulfate compound contained in a water-soluble binder to be a state of hydrate containing crystal water after drying. Also, JP '724 does not teach or suggest the technical idea of using magnesium sulfate in combination with another inorganic sulfate compound (i.e., at least one other inorganic sulfate compound selected from aluminum sulfate, sodium sulfate, nickel sulfate, and manganese sulfate) which easily forms a mixed crystal with the magnesium sulfate at the time of drying, thereby increasing the strength of a water-soluble casting mold at the time of drying, and also restraining the decrease in the strength of the water-soluble casting mold at the time of moisture absorption. Furthermore, JP '724 does not teach or suggest the claimed mixing ratio limitation of the magnesium sulfate being at least 50% by weight and the other inorganic sulfate compound being less than 50% by weight.

A2. JP 54-151508 (JP '508)

JP '508 is directed to a plaster mold. JP '508 discloses a process in which any one compound selected from magnesium sulfate, aluminum sulfate, sodium sulfate, nickel sulfate, manganese sulfate, aluminum phosphate and sodium phosphate is added to plaster (CaSO_4), thereby making a plaster mold soluble by water and increasing its strength at the time of drying.

JP '508 does not teach or suggest using magnesium sulfate in combination with another inorganic sulfate compound (i.e., at least one other inorganic sulfate compound selected from aluminum sulfate, sodium sulfate, nickel sulfate, and manganese sulfate). None of the embodiments of JP '508 teach or suggest a combination of magnesium sulfate and another inorganic sulfate compound. The Applicant notes that a table shown in JP '508 only describes durations for dissolving (collapsing) mold products in varying added amounts of inorganic sulfate compound between 10-70 parts to 100 parts of burnt plaster ($\text{CaSO}_4 \cdot \frac{1}{2} \text{H}_2\text{O}$).

Further, the drying temperatures are exemplified as 200°C, 280°C, and 300°C. Accordingly, no crystal water of inorganic sulfate compound would remain after the drying. Further, JP '508 lacks any description about such crystal water after the drying. An embodiment of JP '508 discloses a process in which 30 parts of sodium sulfate and 60 parts of water are added and mixed with 100 parts of burnt plaster, thereby forming a core which is dried at a temperature of 200°C. However, also in this embodiment, the sodium sulfate in the obtained core becomes an anhydride at approximately 100°C.

As explained above, JP '508 does not teach or suggest the technical idea of increasing the strength of a water-soluble casting mold by adjusting an inorganic sulfate compound contained in a water-soluble binder to be in a state of hydrate containing crystal water after the drying. Also, JP '508 does not teach or suggest the technical idea of using magnesium sulfate in combination with another inorganic sulfate compound (i.e., at least one other inorganic sulfate compound selected from aluminum sulfate, sodium sulfate, nickel sulfate, and manganese sulfate) which easily forms a mixed crystal with the magnesium sulfate

at the time of drying, thereby increasing the strength of a water-soluble casting mold at the time of drying, and also restraining the decrease in the strength of the water-soluble casting mold at the time of moisture absorption. Furthermore, JP '508 does not teach or suggest the claimed mixing ratio limitation of the magnesium sulfate being at least 50% by weight and the other inorganic sulfate compound being less than 50% by weight.

A3. U.S. Patent No. 4,941,938 (Karlsson)

Karlsson is directed to a method of joining two or more surfaces together by applying to at least one of the surfaces a water-based adhesive or an adhesive which liberates water during curing. Karlsson discloses improving the dimensional stability and the strength of jointed part by using such adhesives. The method disclosed in Karlsson belongs to a quite different technical field from that of the claimed invention.

In any event, Karlsson does not teach or suggest the technical idea of using magnesium sulfate in combination with another inorganic sulfate compound (i.e., at least one other inorganic sulfate compound selected from aluminum sulfate, sodium sulfate, nickel sulfate, and manganese sulfate) as a binder of casting sand. Also, Karlsson does not teach or suggest the claimed mixing ratio limitation of the magnesium sulfate being at least 50% by weight and the other inorganic sulfate compound being less than 50% by weight.

A4. The Rejection of Claims 1, 3, 5, 7, and 10 under 35 U.S.C. § 103(a)

In view of the foregoing amendments and remarks, the claimed invention as set forth in amended independent claims 1 and 7 is patentable under 35 U.S.C. § 103(a) over JP '724 in view of JP '508 in view of Karlsson. Claims 3, 5, and 10 depend from one of amended independent claims 1 and 7 and include the limitations of their respective independent claim. Accordingly, the Applicant respectfully requests reconsideration and withdrawal of the rejection to claims 1, 3, 5, 7, and 10 under 35 U.S.C. § 103(a).

B1. U.S. Patent No. 4,423,764 (Seeney)

Seeney discloses using aluminum dihydrogen phosphate and potassium polyphosphate for binder and hardener of casting molds (see col. 1, lines 33-43 of Seeney). Seeney does not teach or suggest the technical idea of making an inorganic sulfate compound exist in a state of hydrate containing crystal water after drying, and thereby, increasing the strength of a water-soluble casting mold. Also, Seeney does not teach or suggest using various phosphate compounds together with an inorganic sulfate compound so as to retain the water-solubility of the mold and improve the heat resistance. Furthermore, the Applicant notes that aluminum dihydrogen phosphate has no effect in enhancing the heat resistance of a water-soluble casting mold, even if it is combined with magnesium sulfate heptahydrate.

Further, Seeney does not teach or suggest the technical idea of using magnesium sulfate in combination with another inorganic sulfate compound (i.e., at least one other inorganic sulfate compound selected from aluminum sulfate, sodium sulfate, nickel sulfate, and manganese sulfate) which easily forms a mixed crystal with the magnesium sulfate at the time of drying, thereby increasing the strength of a water-soluble casting mold at the time of drying, and also restraining the decrease in the strength of the water-soluble casting mold at the time of moisture absorption.

Furthermore, Seeney does not teach or suggest the technical idea of using some kind of phosphate compounds in combination with an inorganic sulfate compound, thereby enhancing the heat resistance property of the casting mold while keeping a water-soluble property thereof.

B2. The Rejection of Claims 4 and 9

In view of the foregoing amendments and remarks, the claimed invention as set forth in claims 4 and 9 (which respectively depend from amended independent claims 1 and 7) are patentable under 35 U.S.C. § 103(a) over JP '724 in view of JP '508 in view of Karlsson in view of Seeney. Accordingly, the Applicant respectfully requests reconsideration and withdrawal of the rejection to claims 4 and 9 under 35 U.S.C. § 103(a).

C1. U.S. Patent No. 4,812,278 (Natori)

Natori discloses a process in which magnesium chloride is used as water-soluble binder for casting mold, thereby facilitating the removal (collapsing) of the mold by water. However, the collapsing property of the mold by water is poor when using only magnesium chloride.

Natori does not teach or suggest the technical idea of increasing the strength of a water-soluble casting mold by adjusting an inorganic sulfate compound contained in a water-soluble binder to be a state of hydrate containing crystal water after drying. Also, Natori does not teach or suggest the technical idea of using magnesium sulfate in combination with another inorganic sulfate compound (i.e., at least one other inorganic sulfate compound selected from aluminum sulfate, sodium sulfate, nickel sulfate, and manganese sulfate) which easily forms a mixed crystal with the magnesium sulfate at the time of drying, thereby increasing the strength of a water-soluble casting mold at the time of drying, and also restraining the decrease in the strength of the water-soluble casting mold at the time of moisture absorption. Furthermore, Natori does not teach or suggest the claimed mixing ratio limitation of the magnesium sulfate being at least 50% by weight and the other inorganic sulfate compound being less than 50% by weight.

C2. The Rejection of Claims 6 and 11

In view of the foregoing amendments and remarks, the claimed invention as set forth in claims 6 and 11 (which respectively depend from amended independent claims 1 and 7) are patentable under 35 U.S.C. § 103(a) over JP '724 in view of JP '508 in view of Karlsson in view of Natori. Accordingly, the Applicant respectfully requests reconsideration and withdrawal of the rejection to claims 6 and 11 under 35 U.S.C. § 103(a).

D1. U.S. Patent No. 5,573,055 (Melling)

Melling is directed to a water dispersible casting mold. Melling discloses a process for obtaining a casting mold in which a water-insoluble particulate material, a binder including water-soluble polyphosphate glass and/or borate glass and water are mixed. A

casting mold is formed using the mixture. Thereafter, free water from the mixture is removed by microwave heating. In this process, water-soluble polyphosphate glass and/or borate glass after heating are supposed to exist in a state of hydrate and Melling suggests that the strength of the casting mold can be increased. However, the base material of the binder disclosed in Melling is completely different from that the claimed binder.

Further, Melling does not teach or suggest the technical idea of using magnesium sulfate in combination with another inorganic sulfate compound (i.e., at least one other inorganic sulfate compound selected from aluminum sulfate, sodium sulfate, nickel sulfate, and manganese sulfate) which easily forms a mixed crystal with the magnesium sulfate at the time of drying, thereby increasing the strength of a water-soluble casting mold at the time of drying, and also restraining the decrease in the strength of the water-soluble casting mold at the time of moisture absorption. Furthermore, Melling does not teach or suggest the claimed mixing ratio limitation of the magnesium sulfate being at least 50% by weight and the other inorganic sulfate compound being less than 50% by weight.

D2. The Rejection of Claim 12

In view of the foregoing amendments and remarks, the claimed invention as set forth in claim 12 (which depends from amended independent claim 7) is patentable under 35 U.S.C. § 103(a) over JP '724 in view of JP '508 in view of Karlsson in view of Melling. Accordingly, the Applicant respectfully requests reconsideration and withdrawal of the rejection to claim 12 under 35 U.S.C. § 103(a).

E1. U.S. Patent No. 4,761,264 (Nishio)

Nishio is directed to a method for molding powders by using a cold isostatic press method. In this method, a thin-wall resilient mold is introduced inside a ventilative mold support, thereafter, the outside pressure of the ventilative mold support is reduced to less than atmospheric pressure, thereby, the thin-wall resilient mold is put exactly close to the inside wall of the ventilative mold support. Powder material is then supplied into the thin-wall resilient mold.

That is, in the method of Nishio, the function of the ventilative mold support is to make the thin-wall resilient mold put exactly close to the inside wall thereof by forming a vacuum inside the ventilative mold support. In the claimed invention as set forth in claim 13, a ventilative ceramic mold which is to be filled with the casting sand is used to release the evaporated water evenly to the outside from the ceramic mold at the time of drying the casting sand. Thereby, unevenness of crystal water contained in the inorganic sulfate compound is restrained, so that the strength of the manufactured mold can be made uniform. As such, the function of the ventilative ceramic mold in the claimed invention as set forth in claim 13 is quite different from that of the ventilative mold support disclosed by Nishio.

Further, Nishio does not teach or suggest the technical idea of making the inorganic sulfate compound exist in a state of hydrate containing crystal water after drying, and thereby increasing the strength of a water-soluble casting mold. Furthermore, Nishio does not teach or suggest the technical idea of using magnesium sulfate in combination with another inorganic sulfate compound (i.e., at least one other inorganic sulfate compound selected from aluminum sulfate, sodium sulfate, nickel sulfate, and manganese sulfate) which easily forms a mixed crystal with the magnesium sulfate at the time of drying, thereby increasing the strength of a water-soluble casting mold at the time of drying, and also restraining the decrease in the strength of the water-soluble casting mold at the time of moisture absorption.

E2. The Rejection of Claim 13

In view of the foregoing amendments and remarks, the claimed invention as set forth in claim 13 (which depends from amended independent claim 7) is patentable under 35 U.S.C. § 103(a) over JP '724 in view of JP '508 in view of Karlsson in view of Nishio. Accordingly, the Applicant respectfully requests reconsideration and withdrawal of the rejection to claim 13 under 35 U.S.C. § 103(a).

CONCLUSION

In summary, claims 1, 3-7, and 9-13, as amended, meet the substantive requirements for patentability. The case is in appropriate condition for allowance. Accordingly, such action is respectfully requested.

If a telephone or video conference would expedite allowance or resolve any further questions, such a conference is invited at the convenience of the Examiner.

Respectfully submitted,

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